WHAT IS CLAIMED IS:

1. A method of numerical analysis of a simulation of a physical system, the physical system being describable by field equations in which a parameter is identifiable as a one-form and solving for a field equation corresponding to the parameter results in a singular differential operation, the method comprising:

directly solving the field equations modified by addition of a dummy field by numerical analysis, and

outputting at least one parameter relating to a physical property of the system.

2. An apparatus for numerical analysis of a simulation of a physical system, the physical system being describable by field equations in which a parameter is identifiable as a one-form and solving for a field equation corresponding to the parameter results in a singular differential operation, the apparatus comprising:

means for solving by numerical analysis a modification of the field equations, the modification being an addition of a dummy field,and

means for outputting at least one parameter relating to a physical property of the system.

3. A data structure for use in numerical analysis of a simulation of a physical system, the physical system being describable by field equations in which a parameter is identifiable as a one-form and solving for a field equation corresponding to the parameter results in a singular differential operation, the field equations being modified by addition of a dummy field, wherein the data structure comprises the simulation of the physical system as a representation of an n-dimensional mesh in a predetermined domain of the physical system, the mesh comprising nodes and n-1 planes connecting these nodes thereby dividing said domain in n-dimensional first elements whereby each element is defined by 2^n node, the data structure being stored in a memory and comprising representations of the nodes and links between nodes, the data structure also including definitions of a parameter of the dummy field associated with the nodes of the mesh.

4. A data structure for use in numerical analysis of a simulation of a physical system, the physical system being describable by Maxwell's field equations of which the following is a representation:

$$\nabla \times \left(\frac{1}{\mu} \nabla \times \boldsymbol{A} \right) = \boldsymbol{J} - \varepsilon \frac{\partial}{\partial t} \left(\nabla V + \frac{\partial \boldsymbol{A}}{\partial t} \right)$$

$$\nabla \cdot \boldsymbol{A} = 0$$

$$-\nabla(\varepsilon \nabla V) = \rho$$

$$\boldsymbol{E} = -\nabla V - \frac{\partial \boldsymbol{A}}{\partial t}$$

$$\boldsymbol{B} = \nabla \times \boldsymbol{A}$$

where

$$\boldsymbol{J} = \boldsymbol{J}(\boldsymbol{E}, \boldsymbol{B}, t)$$

$$\rho = \rho(\boldsymbol{E}, \boldsymbol{B}, t)$$

the field equations being modified by addition of a dummy field, wherein the data structure comprises the simulation of the physical system as a representation of an n-dimensional mesh in a predetermined domain of the physical system, the mesh comprising nodes and links connecting these nodes thereby dividing said domain in n-dimensional first elements whereby each element is defined by 2^n nodes the data structure being stored in a memory and comprising nodes and links between nodes, the data structure also including definitions of a parameter of the dummy field associated with the nodes of the mesh.

5. A data structure for use in numerical analysis of a simulation of a physical system, the physical system being describable by Maxwell's field equations of which the following is a representation:

$$\nabla \times \left(\frac{1}{\mu} \nabla \times \boldsymbol{A} \right) = \boldsymbol{J} - \varepsilon \frac{\partial}{\partial t} \left(\nabla V + \frac{\partial \boldsymbol{A}}{\partial t} \right)$$

$$\nabla \cdot \boldsymbol{A} = 0$$

$$-\nabla(\varepsilon \nabla V) = \rho$$

$$\boldsymbol{E} = -\nabla V - \frac{\partial \boldsymbol{A}}{\partial t}$$

$$\boldsymbol{B} = \nabla \times \boldsymbol{A}$$

where

$$\boldsymbol{J} = \boldsymbol{J}(\boldsymbol{E}, \boldsymbol{B}, t)$$

$$\rho = \rho(\boldsymbol{E}, \boldsymbol{B}, t)$$

the field equations being modified by addition of a dummy field, wherein the data structure comprises the simulation of the physical system as a representation of an n-dimensional mesh in a predetermined domain of the physical system, the mesh comprising nodes and links connecting these nodes thereby dividing said domain in n-dimensional first elements whereby each element is defined by 2^n node the data structure being stored in a memory and comprising nodes and links between nodes, the data structure also including definitions of the vector potential **A** associated with the links of the mesh.

6. A program storage device readable by a machine and encoding a program of instructions for executing a method of numerically analyzing a simulation of a physical system, the physical system being describable by field equations in which a parameter is identifiable as a one-form and solving for a field equation corresponding to the parameter results in a singular differential operation, the method comprising:

directly solving the field equations modified by addition of a dummy field by numerical analysis, and

outputting at least one parameter relating to a physical property of the system.

7. A program storage device readable by a machine and encoding a program of instructions for executing a method of numerically analyzing a simulation of a physical system, the physical system being describable by Maxwell's field equations of which the following is a representation:

$$\nabla \times \left(\frac{1}{\mu} \nabla \times \boldsymbol{A} \right) = \boldsymbol{J} - \varepsilon \frac{\partial}{\partial t} \left(\nabla V + \frac{\partial \boldsymbol{A}}{\partial t} \right)$$

$$\nabla \cdot \boldsymbol{A} = 0$$

$$-\nabla(\varepsilon \nabla V) = \rho$$

$$\boldsymbol{E} = -\nabla V - \frac{\partial \boldsymbol{A}}{\partial t}$$

$$\boldsymbol{B} = \nabla \times \boldsymbol{A}$$

where

$$\boldsymbol{J} = \boldsymbol{J}(\boldsymbol{E}, \boldsymbol{B}, t)$$

$$\rho = \rho(\boldsymbol{E}, \boldsymbol{B}, t)$$

the method comprising:

directly solving the field equations modified by addition of a dummy field by numerical analysis, and

outputting at least one parameter relating to a physical property of the system.

8. A computer program product for numerical analysis of a simulation of a physical system, the physical system being describable by field equations in which a parameter is identifiable as a one-form and solving for a field equation corresponding to the parameter results in a singular differential operation, the computer program product comprising:

code for solving the field equations modified by addition of a dummy field by numerical analysis, and

code for outputting at least one parameter relating to a physical property of the system.

9. A computer program product for numerical analysis of a simulation of a physical system, the physical system being describable by Maxwell's field equations of which the following is a representation:

$$\nabla \times \left(\frac{1}{\mu} \nabla \times \boldsymbol{A} \right) = \boldsymbol{J} - \varepsilon \frac{\partial}{\partial t} \left(\nabla V + \frac{\partial \boldsymbol{A}}{\partial t} \right)$$

$$\nabla \cdot \boldsymbol{A} = 0$$

$$-\nabla(\varepsilon \nabla V) = \rho$$

$$\boldsymbol{E} = -\nabla V - \frac{\partial \boldsymbol{A}}{\partial t}$$

$$\boldsymbol{B} = \nabla \times \boldsymbol{A}$$

where

$$\boldsymbol{J} = \boldsymbol{J}(\boldsymbol{E}, \boldsymbol{B}, t)$$

$$\rho = \rho(\boldsymbol{E}, \boldsymbol{B}, t)$$

the computer program product comprising:

code for solving the field equations modified by addition of a dummy field by numerical analysis, and

code for outputting at least one parameter relating to a physical property of the system.

10. A method of numerical analysis of a simulation of a physical system, comprising: transmitting from a near location a description of the physical system to a remote location where a processing engine carries out a method of numerically analyszing a simulation of a physical system, the physical system being describable by field equations in which a parameter is identifiable as a one-form and solving for a field equation corresponding to the parameter results in a singular differential operation, the method comprising:

receiving at a near location at least one physical parameter related to the physical system;

directly solving the field equations modified by addition of a dummy field by numerical analysis; and

outputting at least one parameter relating to a physical property of the system.

11. An apparatus for numerical analysis of a simulation of a physical system, the physical system being describable by field equations in which a parameter is identifiable as a one-form and solving for a field equation corresponding to the parameter results in a singular differential operation, the apparatus comprising:

a solving component for solving by numerical analysis a modification of the field equations, the modification being an addition of a dummy field; and

an outputting component for outputting at least one parameter relating to a physical property of the system.

12. An apparatus for numerical analysis of a simulation of a physical system, the physical system being describable by Maxwell's field equations of which the following is a representation:

$$\nabla \times \left(\frac{1}{\mu} \nabla \times \boldsymbol{A} \right) = \boldsymbol{J} - \varepsilon \frac{\partial}{\partial t} \left(\nabla V + \frac{\partial \boldsymbol{A}}{\partial t} \right)$$

$$\nabla \cdot \boldsymbol{A} = 0$$

$$-\nabla(\varepsilon\nabla V) = \rho$$

$$\boldsymbol{E} = -\nabla V - \frac{\partial A}{\partial t}$$

$$\boldsymbol{B} = \nabla \times \boldsymbol{A}$$

where

$$\boldsymbol{J} = \boldsymbol{J}(\boldsymbol{E}, \boldsymbol{B}, t)$$

$$\rho = \rho(\boldsymbol{E}, \boldsymbol{B}, t)$$

the apparatus comprising:

a solving component for directly solving the field equations modified by addition of a dummy field by numerical analysis; and

an outputting component for outputting at least one parameter relating to a physical property of the system.

13. A apparatus according to claim 12, wherein the modified field equations are given by:

$$\nabla \times \left(\frac{1}{\mu} \nabla \times \boldsymbol{A} \right) - \gamma \nabla \chi = \boldsymbol{J} - \varepsilon \frac{\partial}{\partial t} \left(\nabla V + \frac{\partial A}{\partial t} + \frac{\partial \nabla \chi}{\partial t} \right)$$

$$\nabla \cdot \boldsymbol{A} + \nabla^2 \chi = 0$$

$$-\nabla(\varepsilon\nabla V) = \rho$$

$$\boldsymbol{E} = -\nabla \left(V + \frac{\partial \chi}{\partial t} \right) - \frac{\partial A}{\partial t}$$

$\boldsymbol{B} = \nabla \times (\boldsymbol{A} + \nabla \chi)$ where χ represents the dummy field and γ is non-zero.

14. An apparatus according to claim 13, wherein the representation of the physical system is a representation of an n-dimensional mesh in a predetermined domain of the physical system, the mesh comprising nodes and n-1 planes connecting these nodes thereby dividing said domain in n-dimensional first elements whereby each element is defined by 2^n nodes, a representation of the mesh being stored in a memory of a computer system as a data structure comprising nodes and links between nodes, the data structure also including definitions of the vector potential **A** associated with the links of the mesh.

15. An apparatus according to claim 13, wherein the representation of the physical system is a representation of an n-dimensional mesh in a predetermined domain of the

physical system, the mesh comprising nodes and links connecting these nodes thereby dividing said domain in n-dimensional first elements whereby each element is defined by 2^n nodes, a representation of the mesh being stored in a memory of a computer system as a data structure comprising nodes and links between nodes, the data structure also including definitions of the dummy field χ associated with the nodes.

16. An apparatus according to claim 12 further comprising:

a creating component for creating a first additional node inside at least one of said first elements by completely splitting said first element into exactly 2^n n-dimensional second elements in such a manner that said first additional node forms a corner node of each of said second elements which results in the replacement of said first element by said 2^n n-dimensional second elements, wherein the creation component creats a second additional node inside at least one of said second elements by completely splitting said second element in exactly 2^n n-dimensional third elements in such a manner that said second additional node forms a corner node of each of said third elements which results in the replacement of said second element by said 2^n n-dimensional third elements, and

a storing component for storing representations of the first and second additional nodes in the memory of the computer system.